Final Report

Maine Outdoor Heritage Fund [MOHF] Project: Aquatic and Upland Habitat Assessment of Merrymeeting Bay

Submitted by Friends of Merrymeeting Bay
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Abstract of Results:

This FOMB research attempted to assess aquatic and upland habitat changes in and around Merrymeeting Bay between 1956 and 1998. The project provides valuable baseline data for future work on this complex system. The project had hoped to compare innovative recent imaging technology with tried and true but perhaps more labor intensive methods. Broadly speaking the project can be divided into four main components. These are 1) data capture using the contrasting technologies of Synthetic Aperture Radar [SAR] imagining and Color Infrared [CIR] photography, 2) SAR/CIR comparison and evaluation, 3) photo interpretation, mapping, and trends analysis of 1956, 1981, and 1998 photographs, 4) education. The largest piece of the project, that of the photo interpretation, mapping and trend analysis, was contracted out to the James. W. Sewall Company.

1. The U.S. Navy has recently been attempting to work more and more with the civilian sector in an effort to help support its' infrastructure. A several day conference was held in 1998 at the Brunswick Naval Air Station [BNAS] to educate state agencies and others in Maine as to the remote sensing technologies the Navy has "for hire."

Deployed on two P-3 aircraft out of Pawtuxent River Naval Air Station in Maryland, these technologies have the potential for more economically evaluating a wide variety of natural resources than with standard methods. Of primary interest in Maine were flyovers of forestland, blueberry cropland and Penobscot Bay. Merrymeeting Bay was incorporated into the demonstration flight to attempt aquatic vegetation imaging and analysis that we could then compare and contrast to color infrared [CIR] aerial photography, the gold standard, but one whose evaluation is very time intensive.

Unfortunately, this part of the project proved unsuccessful. Due apparently to interference from radar [or perhaps radar jamming] emanating from Bath Iron Works [BIW] the Navy SAR was unable to capture any imagery until well north of the Bay. Because our needs were very weather and time sensitive [good light and flight conditions, peak biomass and low tide] it became obvious that the flexibility of a local contractor [as opposed to, in this case the Navy based in Maryland and deployed here for a limited time] would be critical to the success of a project like ours.

2. SAR/CIR comparisons could not be made for the reasons discussed above. While SAR images were captured north of the study area we have no corresponding CIR photographs to compare them to. SAR may still be a viable technology and there may be better techniques, for example hyperspectral scanning [HSS]. The primary issue is probably the flexibility of local deployment of these technologies and not the technologies themselves. We can say, however, that the CIR technology was excellent in that the level of detail and differentiation surpassed that of the earlier black and white and true color photography.

3. Some sample GIS maps and photo sections are attached as supplements to this and or the Sewall report. These show some parts of the study area exhibiting noteworthy changes. The reader is directed to the accompanying James Sewall and Kleinschmidt reports for detailed accounting of methodology and results and to the attached Spring 2000 issue [Vol. 10 Number 2] of Merrymeeting News for a project summary . The highlights are however noted here.

Total aquatic vegetation has decreased about 20% over the study period although most of this was during the period from 1956-1981. With such a long interval it is hard to draw any conclusions about this, however gross pollution [including a lot of nitrogen bearing wastes] was reduced during this period as the Clean Water Act took effect.

Submerged aquatics apparently increased 30% overall with the largest increase between 1981 and 1998. This may partly reflect the actual tide heights at time of photography. While all photographic missions were flown at "low tide" it was found that low tide height can vary by up to 3 feet in a given month. It would appear that this fact was never taken into account in any of the fly-overs but historic tide records [time and heights] were obtained from NOAA during this analysis and attempts were made to understand if various changes were actual or only apparent and based on differing water levels. 1998 was the lowest tide followed by 1956 and then 1981 with the highest water level.

Wild rice showed an increase of 30% over the study period with most of this from 1981 on. Silt and sand increased as well and quite a bit. Both of these facts are borne out by anecdotal observation. Wild rice however is an annual that can vary greatly depending on seed production and dispersal. If sand and silt increases [215% and 140%] are actual [versus reflective of differing water levels] they probably would tend to support habitat more favorable to an annual [wild rice] than perennials [most of the other vegetation].

Water quality and Bay related wildlife habitat are influenced by land use trends in adjacent uplands [Table 1]. Our upland study was limited to a ½ mile buffer around the Bay. Two changes were very evident here when comparing land cover types and buildings over the years. There has been a significant increase in buildings over the study period, in fact, the number of buildings have more than tripled. Agricultural land on the other hand has declined by about 52 % over the study period with some of it transitioning to forest [up 18% for the period] and some to developed areas [up 254 % for period]. As might be expected the subsection showing by far the greatest gain in buildings is the Androscoggin section where growth or sprawl in Brunswick and Topsham is most evident.

4. The education components of this project are several. We have featured three articles in Merrymeeting News on this project and it was the subject of our April Speaker Series [video taped]. We have utilized Geographic Information Systems [GIS] mapping to show changes in aquatic vegetation and land use over time. These maps, as well as scanned photography will be used in our Hands Around the Bay education program as well as to demonstrate to state and local officials how long range planning can influence protection and conservation efforts.

A Review of the Projects Success in Meeting Stated Objectives:

Determination of the current quality and quantity of fisheries and waterfowl habitat, aquatic and upland vegetation, and substrate and assessment of trends over time.

This part of the project achieved mixed success. While quantities and trends of vegetations [habitat] have been well documented by this study, quality is a much more subjective characteristic and not one well understood [at least yet] from this study. Most populations of individual plant species in the Bay appear relatively healthy. Maine Natural Areas Program [MNAP] records show a long presence in the Bay of current species. The diversity of species in the Bay is characteristic of a tidal riverine ecosystem. We do not seem to have species like common reed [Phragmites australis] more commonly found in a Newark, N.J. wetland that might indicate an ecosystem exposed to greater environmental stresses. Wild rice however is one native species that is subject to major infestation by a riceworm. The riceworm eats various parts of the plant including the kernel and may or may not indicate that the plant is under stress. The worm is most common insect pest in commercial rice growing areas.

Using particular species as indicators of water quality is probably not very realistic here either. Because of the broad range of conditions present [currents, high turbidity, fluctuating tidal levels, broad temperature range, some salinity and ice scouring] anything growing successfully out here has to be reasonably adaptable. Then again, there are a range of pollutants some of which [nitrogen and phosphorus bearing] might have an effect on plant growth and thus indirectly on fish, waterfowl and others. Other pollutants [dioxin, DDT or PCB's] probably have no effect on plants yet a substantial direct effect on fish and waterfowl.

A number of things have influenced reverse trends analysis. While upwards of 9 vegetation species were delineated throughout our photo interpretation as they were in earlier studies, a number of factors may make comparisons at the species level [with the exception of wild rice] somewhat questionable. Early studies used a dot grid overlay to identify individual species. Each dot on these grids represented 5/8 of an acre and above each dot a species was identified. In the current study 1/8-acre polygons were drawn around vegetation stands and there needed to be at least a 70% species dominance within that polygon to be typed to a particular species [vs. mixed emergents].

Application and testing of a remote sensing technology rarely used for analysis of vegetation and land use.

The application of SAR technology to this problem was unsuccessful. As mentioned in the abstract this was at least in part a function of the logistical problems encountered in utilizing the Navy to do this work. A contractor of this size based in Maryland was not well suited to executing a mission dependant on time, tides, and weather conditions as well as local unexpected technical problems. Since the Navy first proposed deploying their remote sensing platforms the use of hyperspectral scanning [HSS] has become more widespread and probably would be more suitable for the job than SAR allowing about 256 spectral wavelengths to be detected and recorded. Any technology deployed for a job like this should be locally based at least for the time period around the mission.

Determine how land use surrounding the Bay has changed over time so that future efforts at land protection may focus on the most threatened areas.

This part of the project was an unqualified success. Upland habitat and land use changes were readily apparent and free of some of the variables experienced with the aquatic vegetation analyses. The digitizing of these kinds of data has become fairly common place and creates an important and queriable baseline. What we have done with the addition of historical data appears to be fairly unique at least in Maine.

Evaluate the ecological health of the Bay before dam removal and monitor possible problems

This study was to provide a baseline of conditions prior to the removal of Edwards Dam.
" Evaluating the ecological health " is a broad statement that goes beyond the scope of this study. To perhaps adequately address that issue a whole spectrum of data collection and analysis would need to occur. Included would be things like sediment sampling, identifying point and non-point source polluters and the amounts and effects of the discharges, water quality sampling, tissue sampling of fish, waterfowl and other wildlife, and population studies of many of the species using the Bay including primary production surveys of phytoplanktons.

Education utilizing computer generated maps to show changes over time.

Here again the project was, is, and we expect will continue to be a success. While FOMB membership has been kept well informed about the project it has only recently been completed. With completion comes the opportunity for a presentation that can be taken to schools, state planners and policy makers, and the general public.

Photographs and Publications

Multiple photographs and maps of the project are included in this report and or the two accompanying reports. Additionally, very large format GIS maps have been delivered to the State Planning Office. One public presentation of the project has been made thus far. This took place at Bowdoin College as part of the FOMB Speaker Series. The presentation was video taped and that tape is currently stored in the A/V lab at Bowdoin. As mentioned earlier articles on the project have appeared in three FOMB newsletters *Merrymeeting News* with a circulation of 400.

Follow Up Work

At the time of this report no follow up work has been scheduled though as with any good research more questions have been raised and some original questions remain. Some ideas for future work follow.

1. Establish several permanent study plots or transects around the Bay to study/ monitor vegetation/sand/ silt changes regularly and more frequently. Utilize ground based and possibly aerial photography to establish a visual record of the progression of seasonal succession in the marsh and how this relates to photography captured in this study. Possible partners: MNAP, USFWS, IF&W, SPO, TNC.

2. Work at collecting and synthesizing other data that provide partial indicators of Bay "health" [sediment, tissue, water, polluters, etc.] to formulate a more integrated or holistic assessment and understanding of overall Bay quality. Possible partners: IF&W, DEP, DMR, Bureau of Health [BOH], EPA, USGS, SPO, TNC.

3. Investigate use of HSS for further work. Possible partners: Maine Office of Science and Technology [MOST], Maine Department of Agriculture [MDA], DEP, DMR, USGS, SPO, IF&W, TNC.

4. Presentations to all town governments and appropriate committees around the bay of study findings and implications. Possible partners: SPO, Maine Municipal Association [MMA], TNC.

5. Inclusion in regular FOMB Hands Around the Bay programs or curriculum development. Possible partners: Gulf of Maine Educators Association [GOMEA], Chewonki Foundation.

Feedback on MOHF

Clarity of MOHF principles and application materials was satisfactory. Responsiveness and flexibility of MOHF staff was excellent.

Budget

While there are some differences in the details between the MOHF contributions in the proposed budget that accompanied our project summary and the SPO "Agreement to Purchase Services" the totals are similar [$24,500 in budget and $24,380 in agreement and received]. The bulk of the money was proposed to be paid to our contractor the James Sewall Company and in fact all of it was. Areas of spending were for image interpretation, reverse trends analysis, final map products and reports.

MOHF Beginning Balance:	$24,380.00
FOMB Payments to Sewall:	[15,523.00]
	[4,457.00]
	[5,720.40]
	[259.60]
Total:	[$1580.00]

$1580.00 debit made up by FOMB.

Conclusion:

This study provides a well-documented and excellent baseline to measure future changes against. It also provides a valuable planning tool that illustrates patterns and types of human growth as well as ecological succession. If we are to determine some of how we choose to live in our bayside environment and what it should look like instead of reacting to whatever happens then we must make conscious decisions to utilize tools such as conservation easements, zoning, comprehensive plans, erosion control ordinances, and timber harvesting standards to shape our society and environment. All of these efforts are harder work than just accepting what comes but in meeting the challenge we may pass on to future generations something of this Bay we find so valuable.

Acknowledgements:

This project could not have been completed without the assistance of many partners. FOMB acknowledges and thanks the following partners for the following contributions. This study has been funded in large part by a Maine Outdoor Heritage Fund [MOHF] grant sponsored by the State Planning Office [SPO]. Other project partners contributing financially or in-kind have included the Nature Conservancy [TNC], United States Fish and Wildlife Service [USFWS], Maine Natural Areas Program [MNAP], United States Geological Survey [USGS], and of course FOMB. Historical aerial photography on which the project was built and the 1998 photography compared to was provided courtesy of Maine Department of Inland Fisheries and Wildlife [MDIF&W].

We'd also like to thank David Olsen for the use of his 1958 Masters Thesis: *The Use of Aerial Photographs In Studies of Marsh Vegetation.* The study analyzed the variables of film type, scale, and interpretation as used in aerial photography. This Thesis utilized Merrymeeting Bay as the study area. The superb annotated 1957 photography found therein provided us with the necessary key to successfully interpret the IF &W photography from that period.

Supplemental Map Section
Prepared by Robert Houston, U.S. Fish and Wildlife Service
Gulf of Maine Project

The following maps and the photography from which they were derived are included to illustrate some of the areas showing change over time. The data from which the GIS maps were generated originate from photo interpretation done by the James Sewall Company.

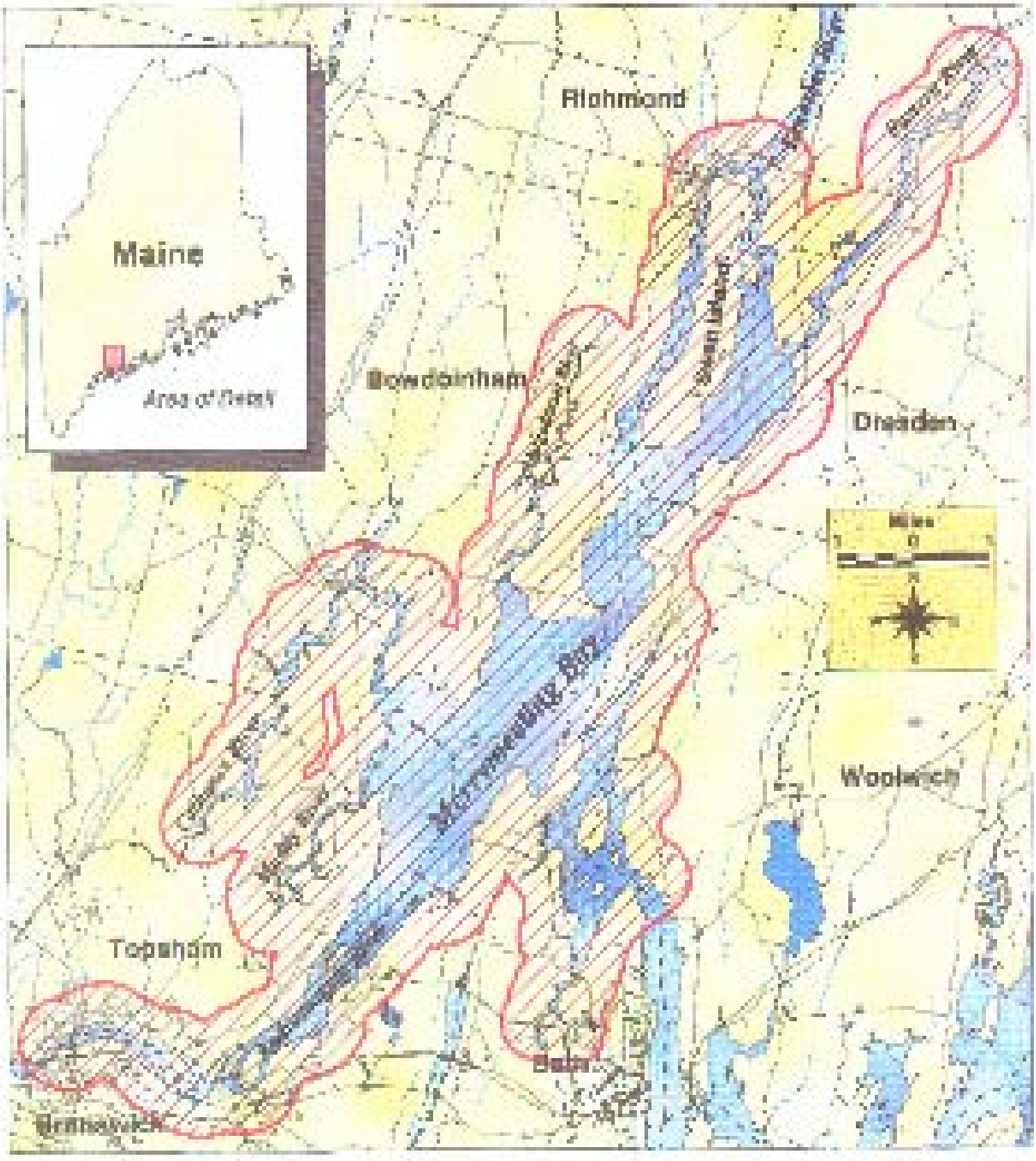
Colors and clarity of the scanned aerial photography show variation due to film type and deterioration over time. The areas of photography roughly correspond to the GIS map sections.

Different photography characteristics were:

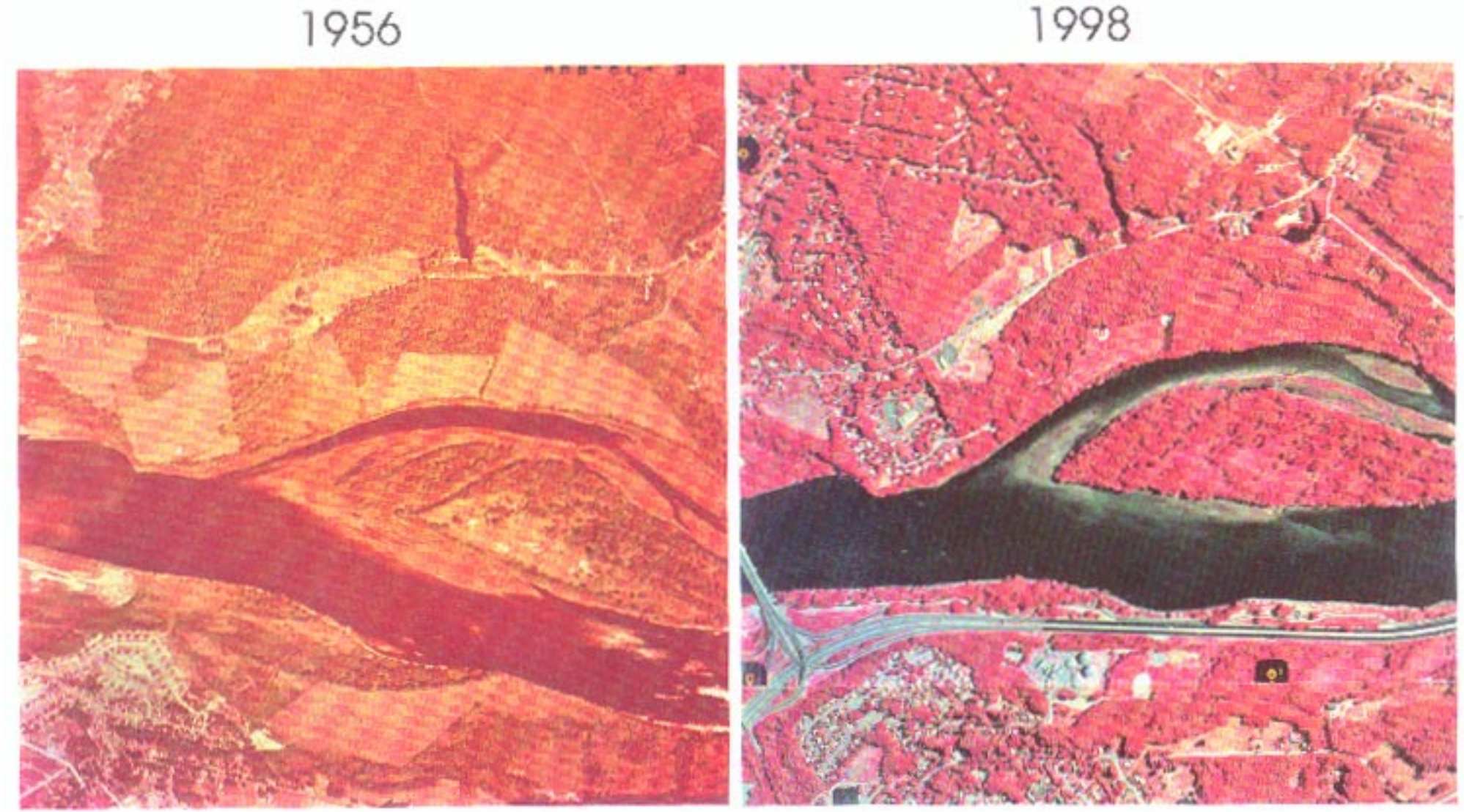
1956	True color positive transparencies, scale 1” = 660’
1981	True color prints, scale 1” = 660’
1998	Color infrared film positives, scale 1” = 1000’

Merrymeeting Bay Habitat Conservation Project

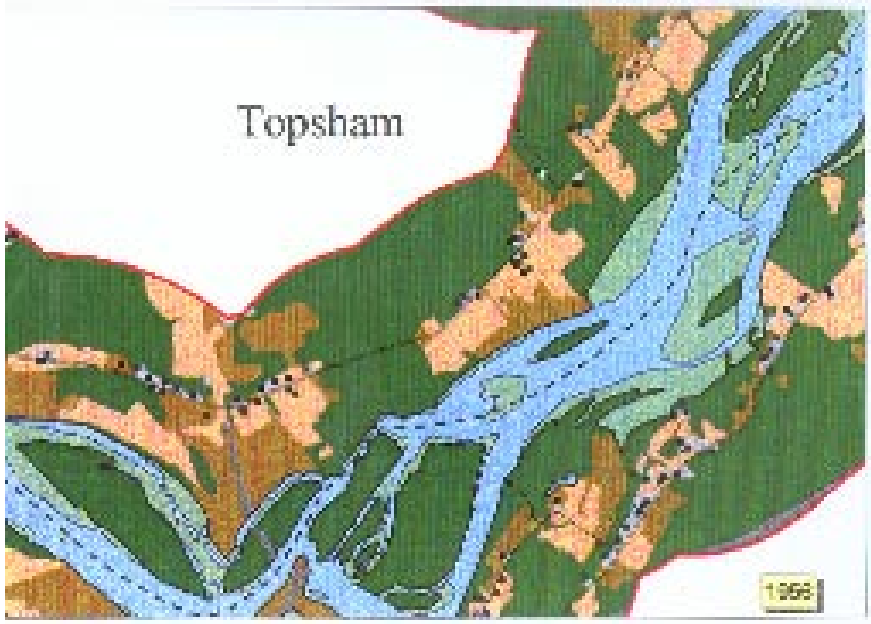
Trends Analysis and Protection of Fish and Wildlife Habitat On and Around Merrymeeting Bay

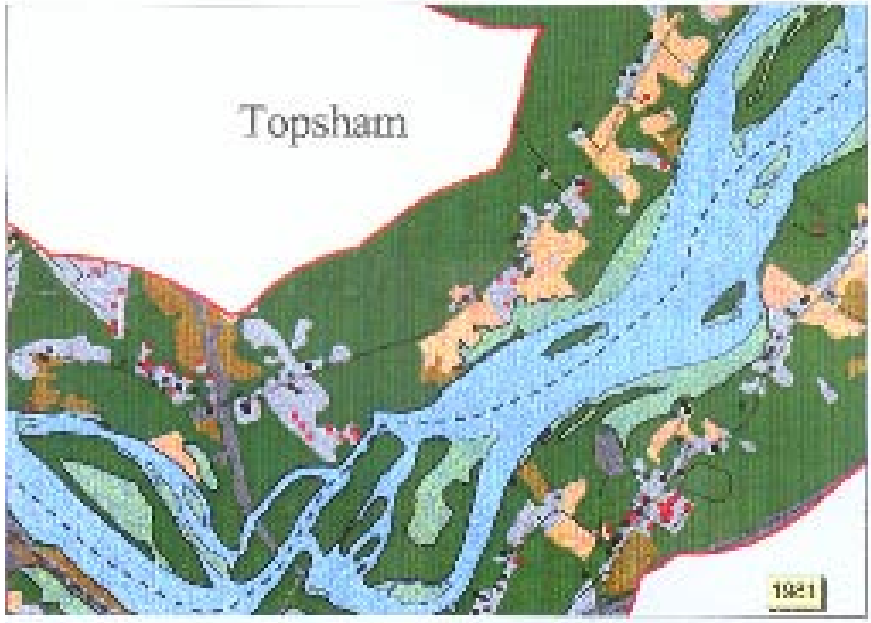


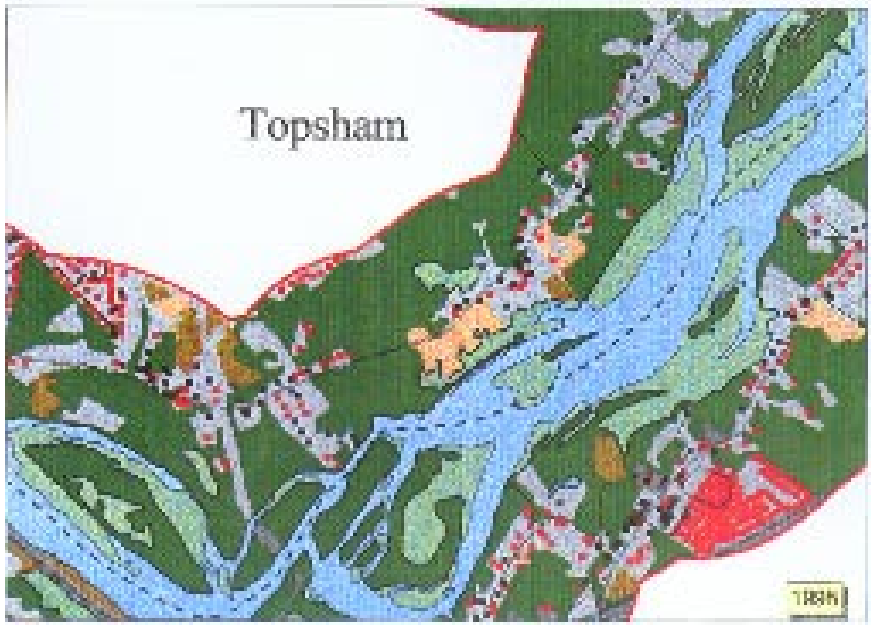
Aerial photos of Brunswick and Topsham (Kennebec River with Cow Island) showing evidence of development and urban sprawl

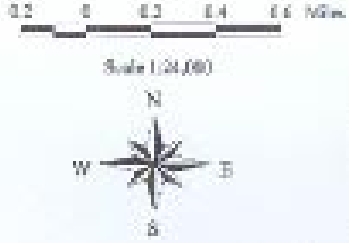


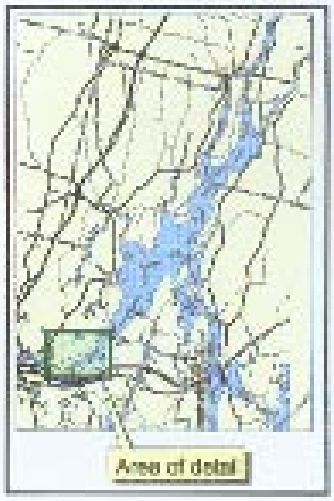
Land Use Change and Residential Buildout - Focus on Topsham/ Brunswick area of the Androscoggin River



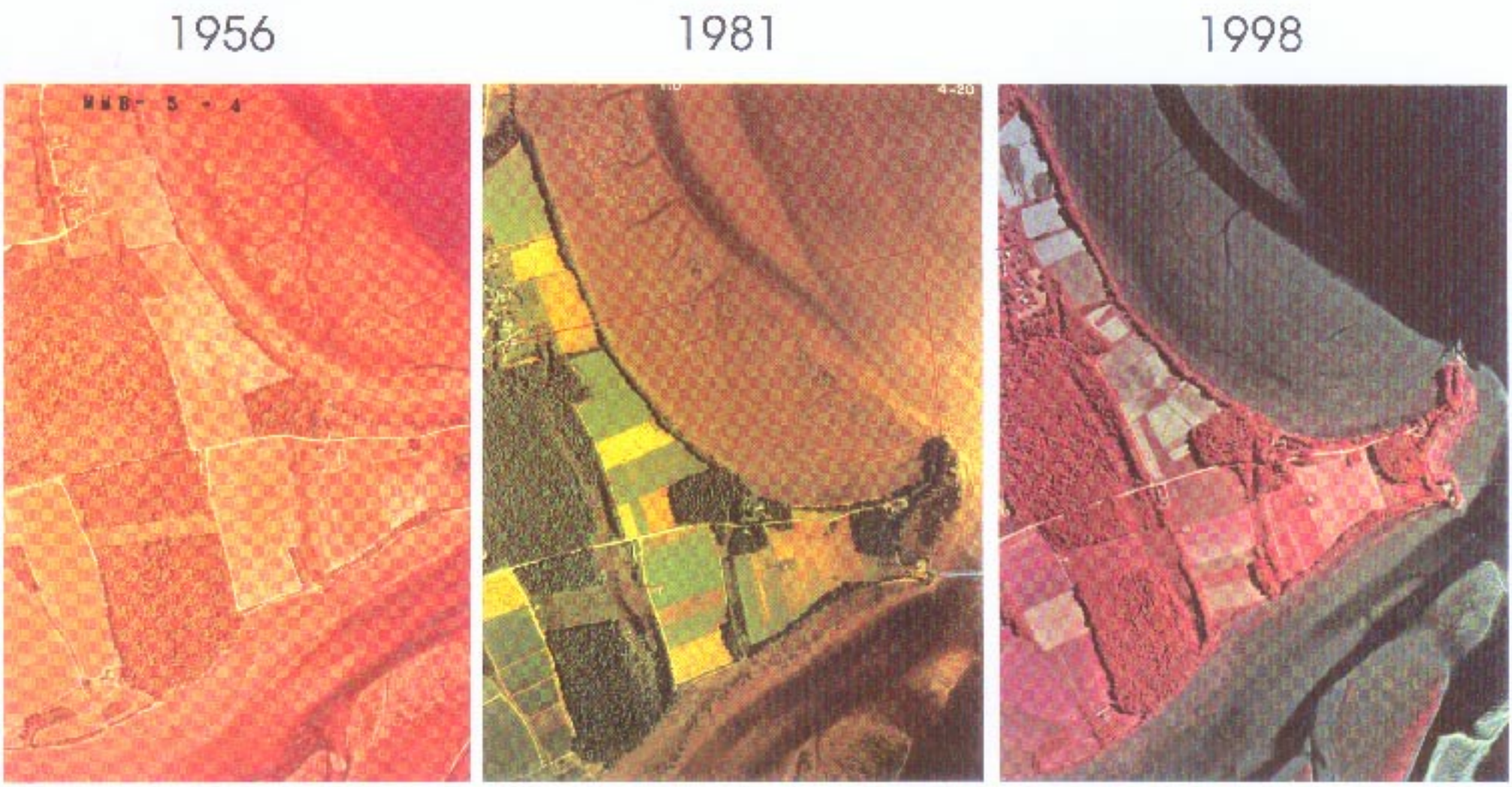


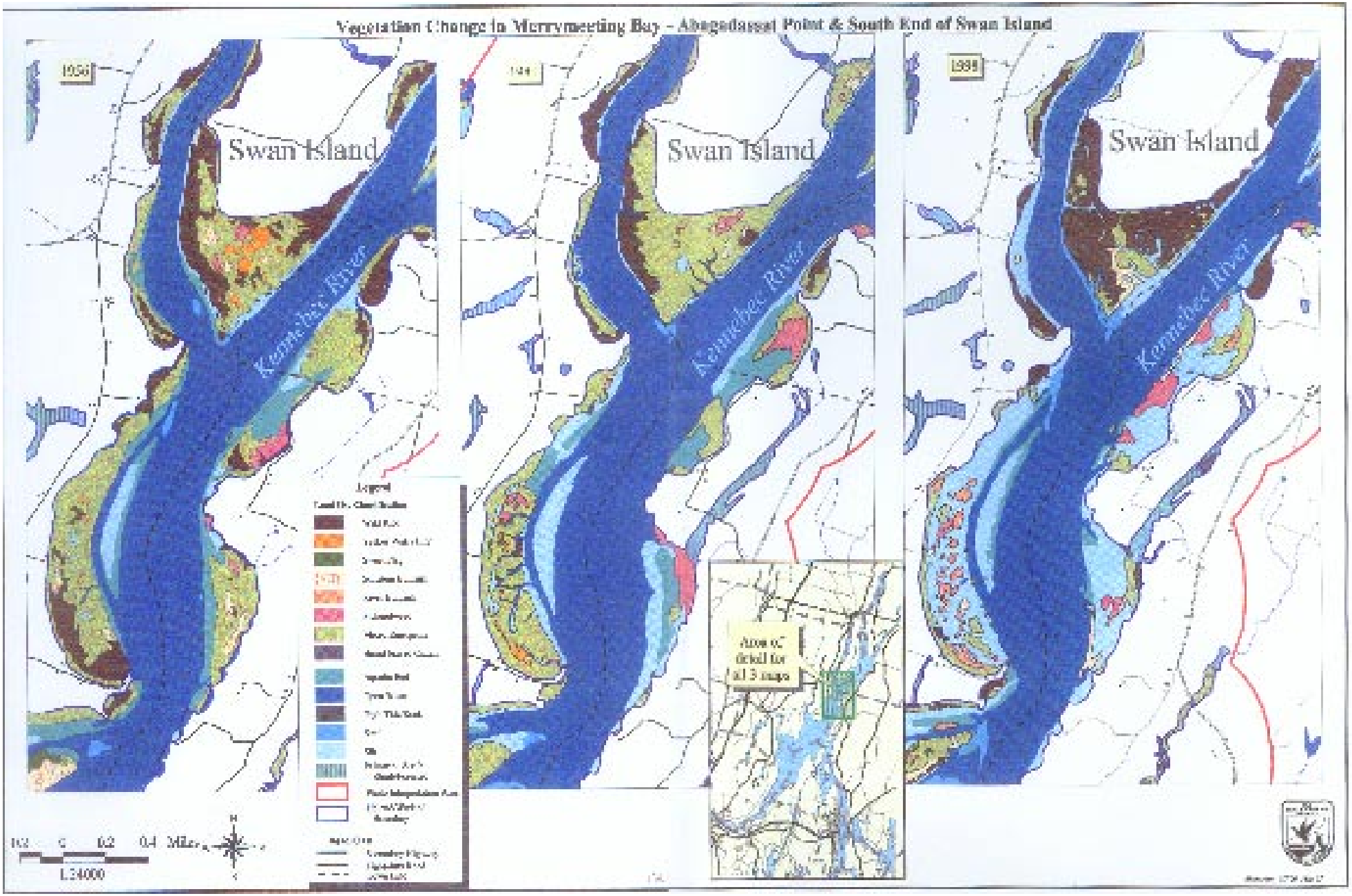




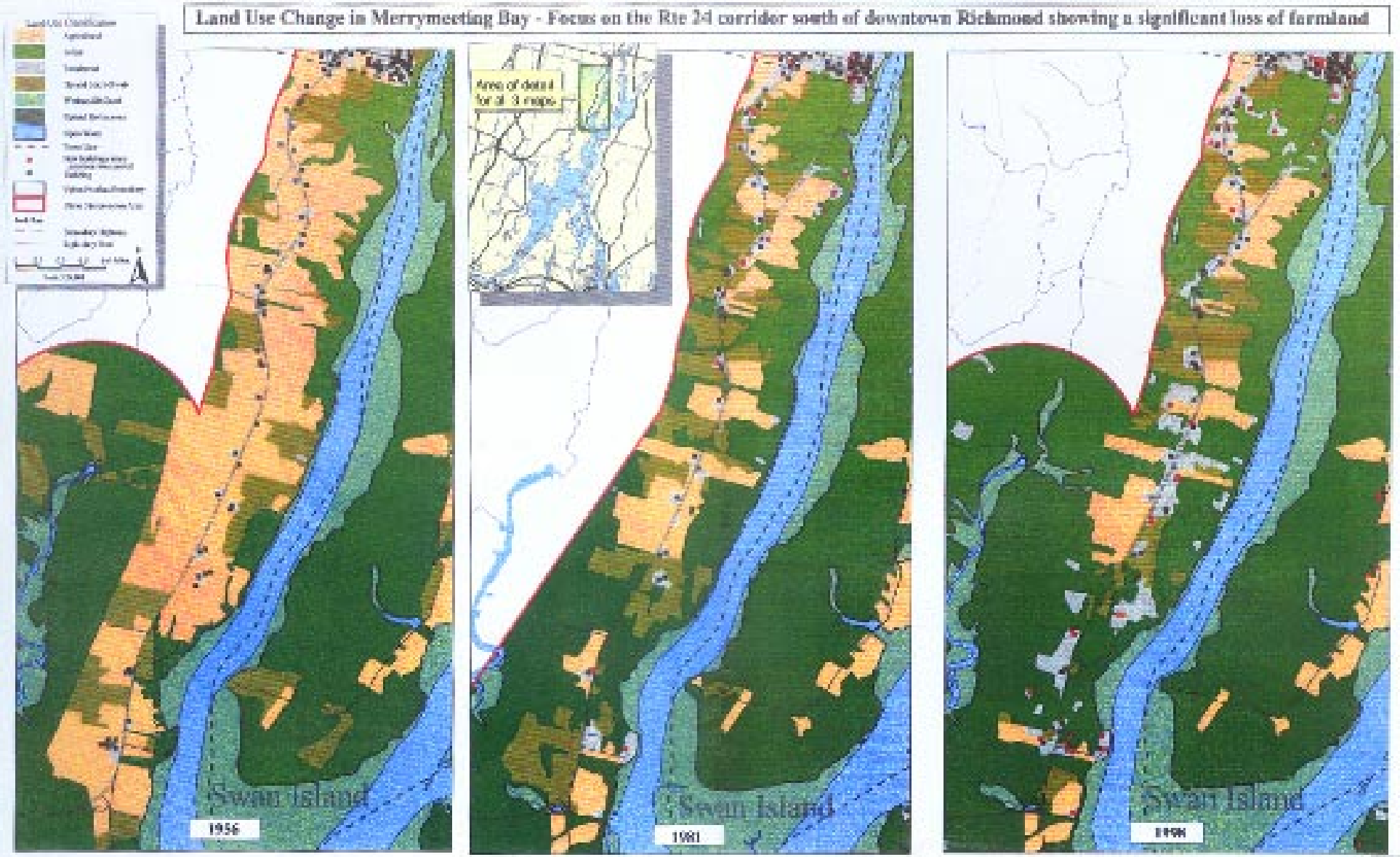


Aerial photos of Abagadassat Point showing vegetation in the emergent marsh just above the point

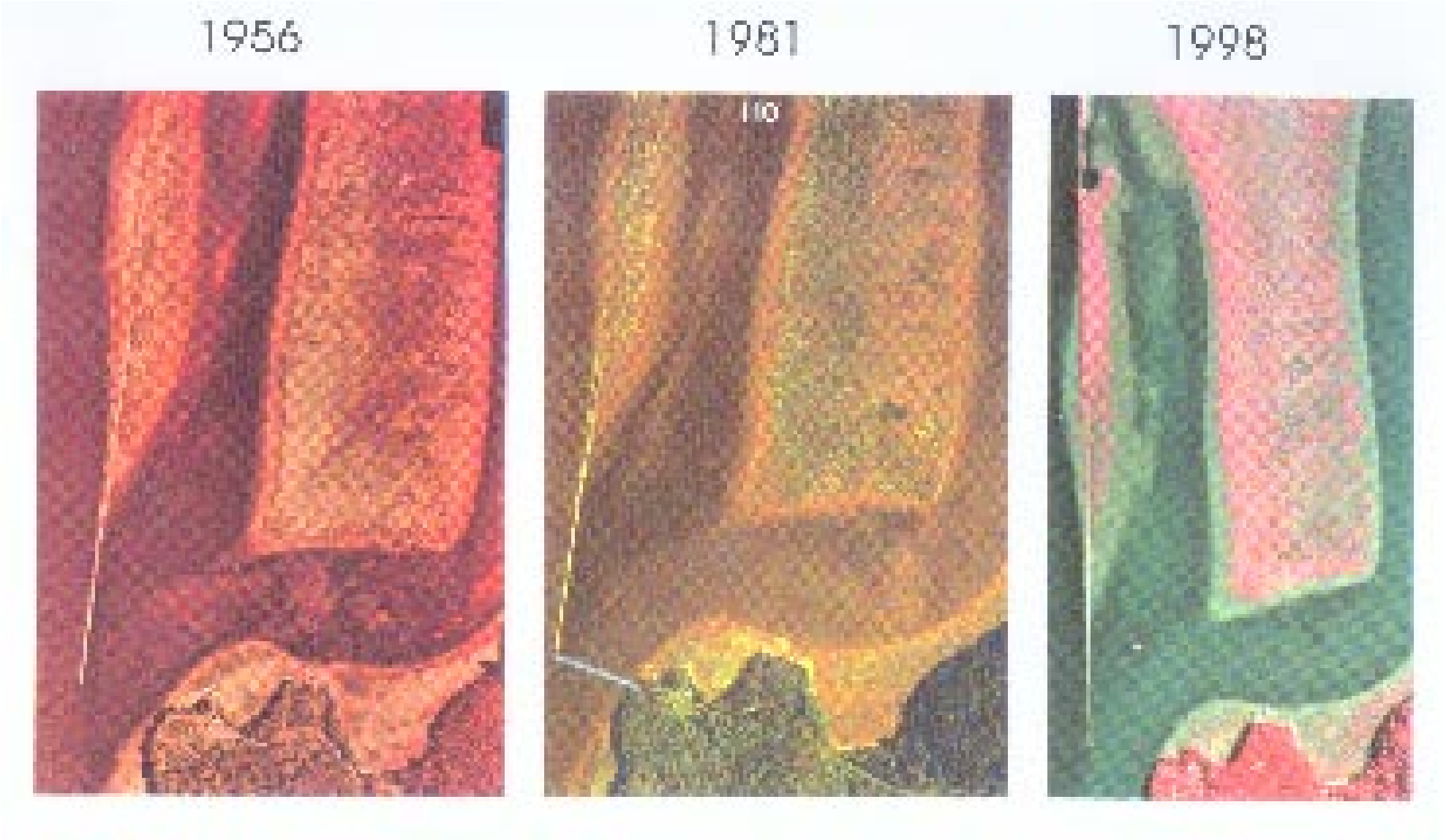



Vegetation Change in Merrymeeting Bay - Abagadasset Point & South End of Swan Island
1956
1971
1988
Swan Island
Swan Island
Swan Island
Kennebec River
Kennebec River
Kennebec River
Area of detail for all 3 maps
Legend
0.2 0 0.2 0.4 Miles
1:24000
N

Land Use Change in Merrymeeting Bay - Focus on the Rte 24 corridor south of downtown Richmond showing a significant loss of farmland



Aerial photos of the mouth of the Eastern River showing vegetation change in the marsh



Vegetation Change in Merrymeeting Bay - Mouth of the Eastern River